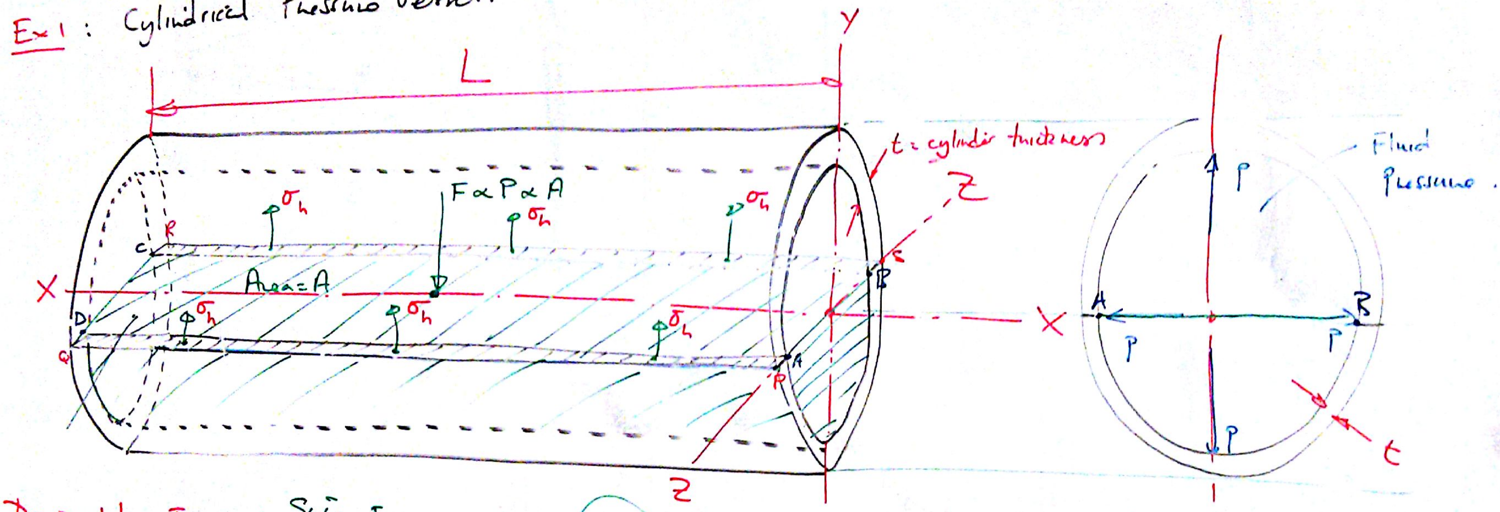
Stress in vessles: cylinders (gases). / spheres (liquids + gases).

XX = longitudinal axis
YY, ZZ, circumferential (Hoop). "h"

Ex 1: Cylindrical Pressure vessel.



Resultant force $F = \sigma_h . A$ Since $F \propto \sigma$ $\Rightarrow$ ie $\sigma = \frac{F}{A}$ $\Rightarrow$ $F = \sigma . A$

$E = \frac{\sigma}{\epsilon}$

$\therefore F = \sigma_h . (2 \times \text{areas CDAP})$

$\therefore F = \sigma_h . [2.L.t]$

$\boxed{F = 2Lt.\sigma}$

Stress in vessels.
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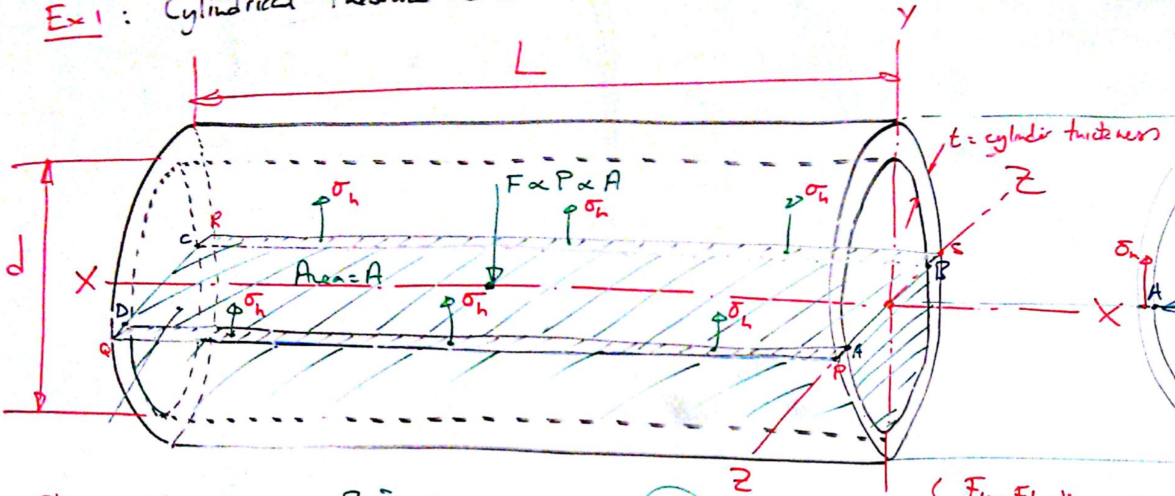
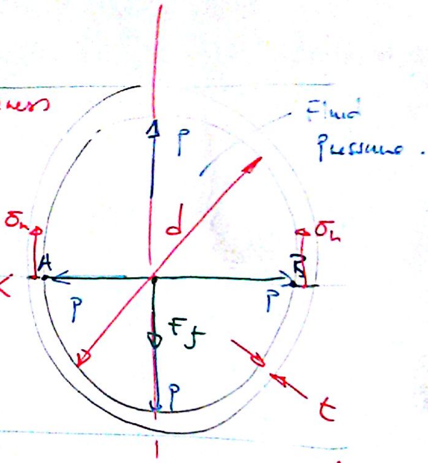
Ex 1 : Cylindrical Pressure vessel.





Downward force $F = \sigma_h . A$ Since $F \propto \sigma$ ⇒ ie $\sigma = \frac{F}{A}$ ⇒ $F = \sigma . A$

$E = \frac{\sigma}{\epsilon}$

$\therefore F = \sigma_h . (2 \times \text{areas CDAP})$

$\therefore F = \sigma_h . [2.L.t]$

$\boxed{F = 2Lt . \sigma_h}$ ⇒ Force in shell opposing the fluid force.

Equate

For Fluid $p = \frac{F}{A}$ ⇒ $F_f = p A$ Area

$\boxed{F_f = p . L d}$

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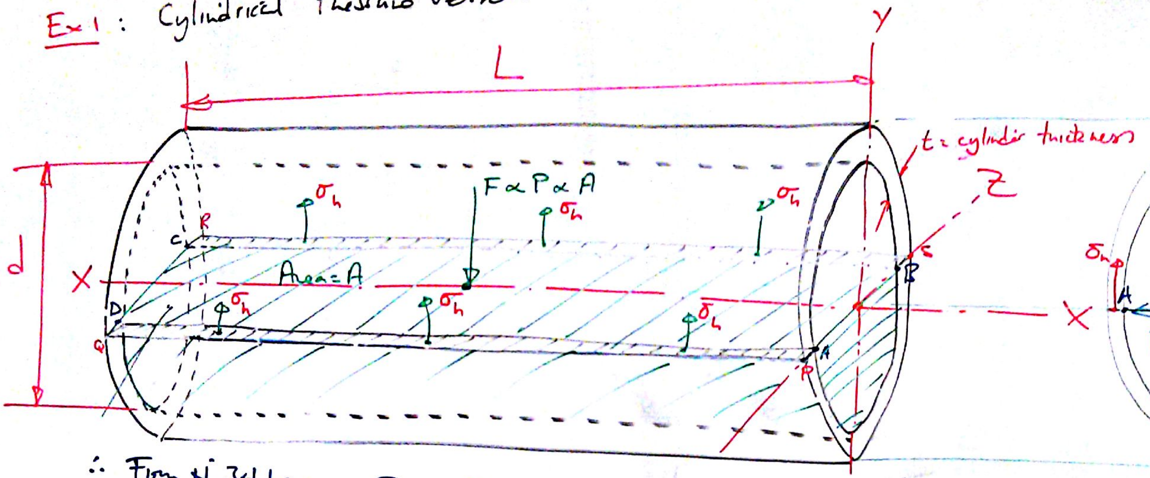

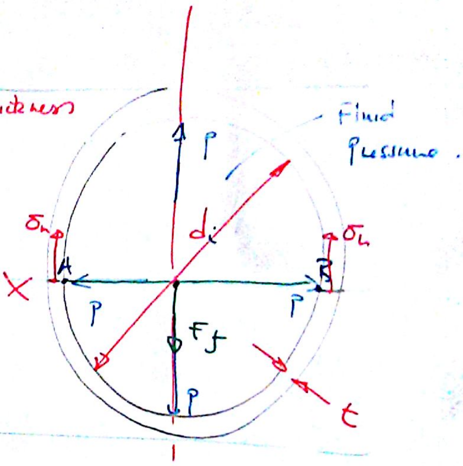

∴ From N 3rd Law. $F_f = F$

∴ $p.L.d = 2Lt\sigma_h$

∴ $\sigma_h = \frac{p.\cancel{L}.d}{2\cancel{L}t} \Rightarrow \boxed{\sigma_h = \frac{p.d}{2t}}$ DEFINES HOOP OR CIRCUMFERENTIAL STRESS

N.B. Holds true only if

$$\frac{d_i}{t} \geq 20:1$$

Stress in vessles. — cylinders (gases).
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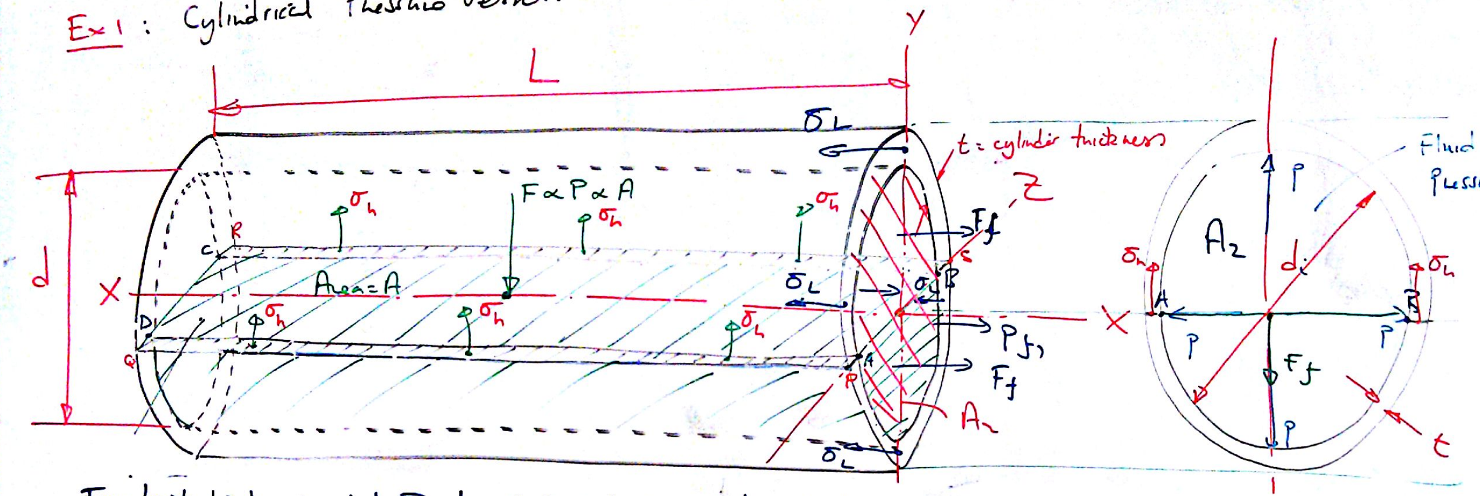
Ex 1 : Cylindrical Pressure vessel.



For logitudinal axis. Let δ_L = longitudinal stress opposing longitudinal pressure p_f acting on A_2

$$\therefore p_f = \frac{F_f}{A_f} = \frac{F_f}{A_2}$$

$$\therefore F_f = p_f . A_2$$

$$F_f = p_f.(\pi r^2)$$

$$F = p.\pi\left[\frac{d}{2}\right]^2 = \frac{p.\pi.d^2}{4}$$

$$\boxed{F = \frac{p.\pi.d^2}{4}} \quad (1)$$

Stress in vessles.
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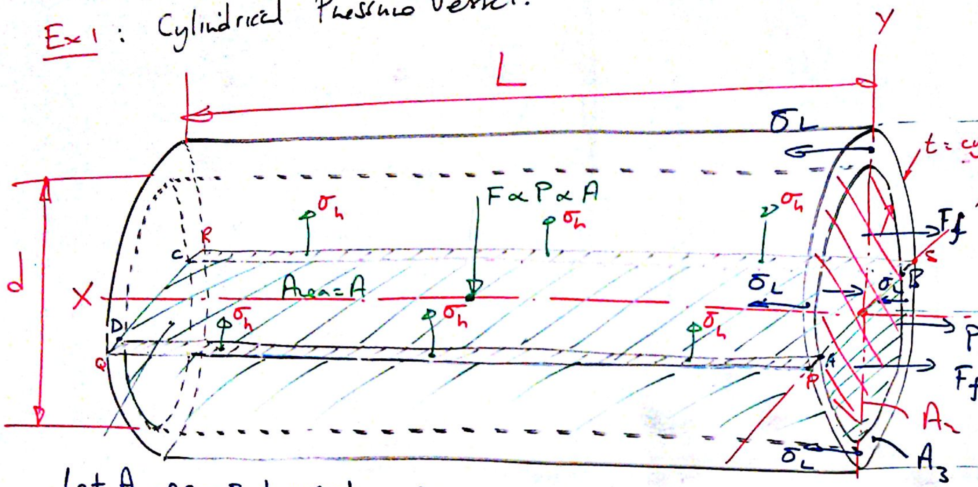
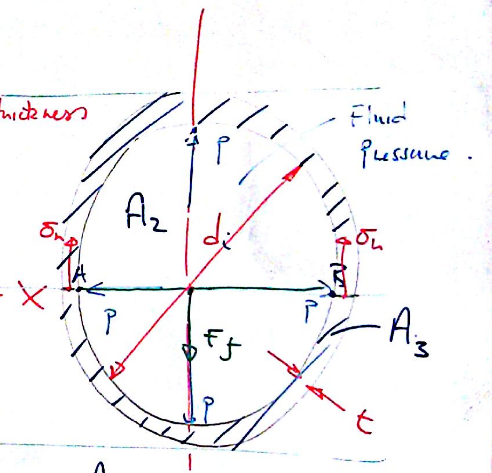
Ex 1 : Cylindrical Pressure vessel.





Let A_3 = csa of the vessel

Pf induces a stress longitudinally.

$\sigma = \frac{F}{A} \Rightarrow F = \sigma . A$ — A_3

$A_3 = 2\pi r . t$

$= 2\pi \frac{d}{2} . t$

$A_3 = \pi . d . t$

$F = \sigma . A_3$

$\boxed{F = \sigma . \pi . d . t}$ — B

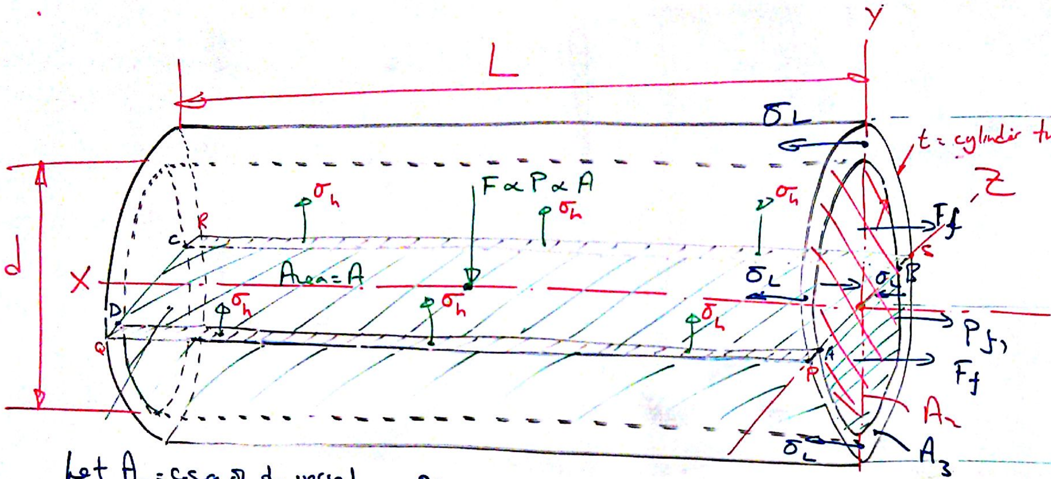
Summary So Far.

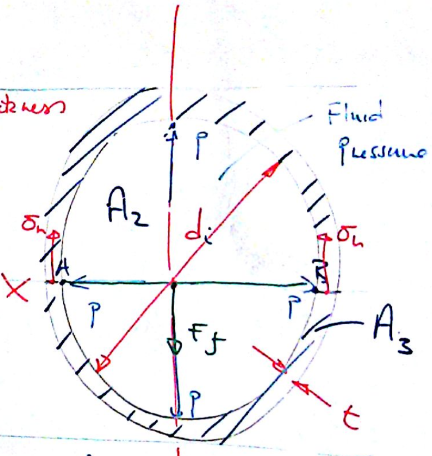
$\sigma_h = \frac{p.d}{2t}$; $\sigma_L = \frac{p.d}{4t}$

XX = longitudinal axis

YY, ZZ, circumferential (Hoop).

"h"





Let A_3 = csa of the vessel

P_f is due a stress longitudinally.

$\sigma = \frac{F}{A} \Rightarrow F = \sigma_L A$ (A) — A_2

$F = \sigma_L A_3$

$\boxed{F = \sigma_L \pi . d . t}$ (B)

$A_3 = 2\pi r . t$

$= 2\pi \frac{d}{2} . t$

$A_3 = \pi . d . t$

∴ Equate (A) + (B) ∴ ie same force opposite direction

$\Rightarrow \frac{p.\pi.d^2}{4} = \sigma_L \cancel{\pi} . \cancel{d} . t$

$\frac{p.d}{4} = \sigma_L . t$

$\Rightarrow \boxed{\sigma_L = \frac{p.d}{4t}}$ Defines longitudinal stress in vessel.